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GEORGIA INSTITUTE OF TECHNOLOGY

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Douglas Aircraft Company, Incorporated
Missiles and Space Systems Division
3000 Ocean Park Boulevard
Santa Monica, California 90406

Attn: D. V. Magill, Manager, Advance Missile Engineering
Advance Missile Technology, Department A-260

Subject: Final Report, Project A-808, Subcontract DAC A 64-444,
"Experimental Thin-Wall Slip-Cast Fused Silica Radomes"

Gentlemen:

Described below are the processes and methods used in fabricating experimental thin-wall slip-cast fused silica radomes for the Douglas Aircraft Company, Incorporated.

The surface finish of the aluminum radome mandrel received from Douglas was not sufficiently smooth and free from machine marks to use for fabricating a satisfactory plaster mold. It was necessary to hand polish the mandrel for approximately 8 hours before suitable surface was obtained. Also, the aluminum tapered tip pin (part number 9 on Douglas's drawing) had an eccentrically machined thread. When this pin was removed from the mold, it forced the radome mandrel tip to one side and undercut that side of the mold, ruining it.

Rather than use the other part number 9, (stainless steel tapered pin) it was decided to change the mandrel and plaster mold design. A straight sided stainless steel tube was threaded and used in the end of the mandrel so as to provide a straight walled hole in the end of the plaster mold. Prior to casting the mold, a plastic guide was inserted into the plaster dam so that on casting the insert was 1/4-inch below the inner surface of the mold. This insert prevented accidental side pressure on the mold when the tubing was removed. Six molds were prepared, using a 5 to 4 by weight plaster to water ratio, and dried at 120° F for one week prior to use.

A modified slip-casting technique was developed to obtain the desired taper in wall thickness. With the mold in the "tip-up" position, fused silica slip was introduced into the bottom of the mold by applying a positive pressure to the slip. The air in the mold was allowed to escape through the hole in the tip of the mold. Although the basic technique was established prior to initiation of this work, it was necessary to determine the proper conditions of filling, casting, and draining time, and of casting pressure to produce radomes of the proper wall thickness and taper.

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Figure 1 shows the set-up used for pressure casting thin-wall radomes. The pressure tank A contains the fused silica slip; B is the mold; hose 1 connects the air supply and pressure tank; and hose 2, the pressure tank and plaster mold through valve C. Valve D is used to drain the mold. Valve E is permanently attached to ten inches of stainless steel tubing and is open during the fill and drain cycles. Tubing 3 is used to drain excess slip. F is the pressure regulator; and G is the mold support dolly.

The initial surge of slip during the fill time, between 1-1/2 and 1-3/4 minutes, and at a pressure of 10 psig, splattered the side of the casting surface and resulted in an irregular structure. A baffle 5 inserted on the mold side of valve C prevented this defect.

The most successful casting procedure was:

1. Fill mold at 10 psig in a time interval of 1-1/2 to 1-3/4 minutes with valves C and E open; tube must be flush with tip of mold.

2. Close valve E; insert tube 1/2-inch into mold cavity.

3. Cast at 10 psig for eight minutes.

4. Close valve C and remove hose 2.

5. Open valves D and E; adjust valve D for a drain time interval of 6-1/2 to 7 minutes; remove tube.

6. Open valve C and allow one hour set time.

7. Rotate mold, remove cover, and air dry two hours in mold.

Fourteen radomes were cast during the contract period. Two were discarded because of splattering defects. The tips of three radomes adhered to the mold and broke off.

Three radomes cracked as a result of cristobalite formation when the ware was sintered. The normal firing time of 3-1/4 hours at a temperature of 2200° F was found to be too long. Subsequently, the time was lowered to 2-1/2 hours. All radomes were surrounded by an inconel shield during sintering.

Six radomes were delivered; however, only one was within the exact wall thickness tolerances required. Since these radomes were fabricated using experimental procedures, it was not possible to meet repeatedly the desired

tolerances. To do so would require more time and more sophisticated equipment.

Respectfully submitted,

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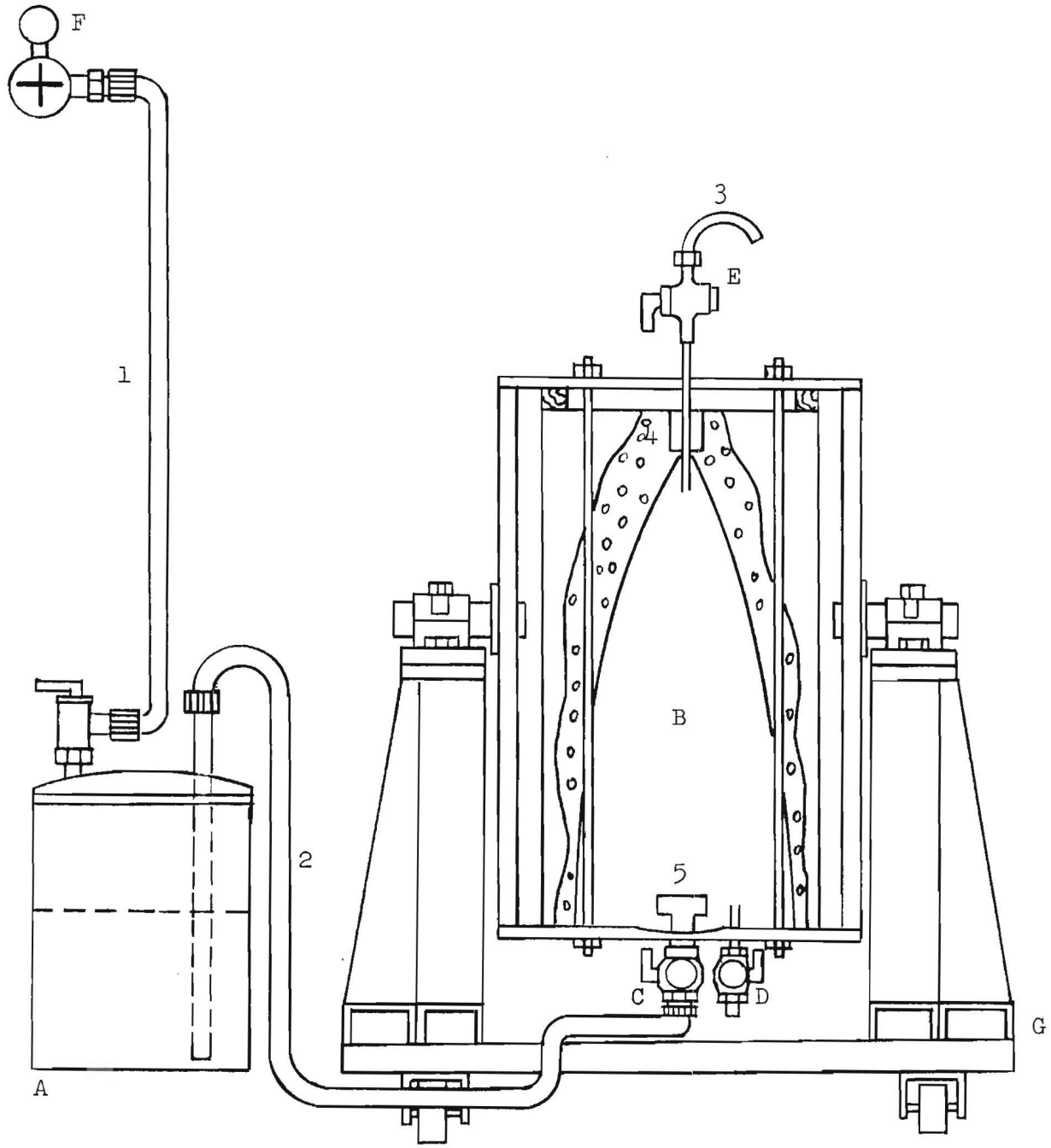

Figure 1. Layout of Apparatus Used to Slip-Cast Thin-Wall Fused Silica Radomes.